TRIP REPORT

BANGLADESH

FORTIFICATION OF FOOD WITH VITAMIN A 1/

by

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A. PURPOSE

The purpose of this trip was to assist Helen Keller International (HKI), a U.S.-based private voluntary organization, review options for alleviating vitamin A deficiency in Bangladesh through fortification of food. The scope-of-work included the following tasks (1):

- Review previous studies and reports and other information on the possibilities of fortifying food with vitamin A to increase consumption among those groups in the population most vulnerable to vitamin A deficiency,

- Study the feasibility of fortifying specific food products with vitamin A, and analyze the prospects and problems of each potential product,

- Recommend whether an effective vitamin A food fortification program can be developed in Bangladesh and if so,

- Develop a description of an appropriate vitamin A food fortification project which would be feasible in Bangladesh.

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B. SUMMARY

Vitamin A deficiency is a serious problem in Bangladesh. Recent estimates indicates that 70,000,000 persons are chronically deficient, 900,000 children under six years of age have some form of eye disease due to vitamin A deficiency, and 30,000 children are blinded each year due to severe vitamin A deficiency.

The major effort to alleviate vitamin A deficiency in Bangladesh is distribution of vitamin A capsules to young children through the Bangladesh Programme for the Prevention of Blindness (BPPB). The program reaches 8 million children and is believed to prevent 8,000 children a year from going blind. However additional programs are required to cope with the problem, particularly ones which can reach the poorest of the poor on a sustained basis.

In this study, possibilities for alleviating vitamin A deficiency through food fortification were reviewed. Foods which were considered as potential carriers for vitamin A included rice, wheat, sugar, salt, vegetable oil, biscuits, and tea. Of these, only wheat fortification appears to be feasible. Rice does not pass through centralized faciities where fortification could be controlled. Refined sugar is not consumed by the primary target group and unrefined sugar (gur) is not amenable to fortification. The salt distributed in Bangladesh is "wet" and a technology is not yet available with which to protect the vitamin A against loss of potency in "wet" salt. Vegetable oil, biscuits, and tea are not consumed regularly or in sufficient quantity among the target group to be able to supply beneficial amounts of vitamin A. On the other hand, wheat is consmed by low income families in significant amounts and can be fortified by adapting a standard technology now in use for fortifying rice. Imported wheat, which is currently distributed to up to 20-25 million destitute and very low income

persons through the GOB's Vunerable Group Feeding Program and Food for Work Program might be fortified with vitamin A. Costs for fortification of the 650,000 tons of wheat used annually in these rograms are estimated to be US $1-2 million per year.

It is recommended that possibilities for fortification of wheat should be examined in greater depth through feasibility studies to explore: (1) the adaptability of the existing GOB wheat distribution system to fortify and deliver the wheat used in the VGF and FFW programs and (2) the wheat consumption patterns of VGF and FFW beneficiaries to assess potential impact of wheat fortification. If the feasibility studies yield favorable results, it is recommended that wheat fortification project proposal be prepared for consideration by the GOB and appropriate funding agencies.

C. BACKGROUND

Vitamin A deficiency is recognized as a serious nutritional problem in Bangladesh. A 1982-3 Nutritional Blindness Study sponsored by HKI provided an overview of the problem (2). The report concluded that 30,000 children in Bangladesh are blinded each year due to severe vitamin A deficiency and 900,000 children under six years of age suffer some form of eye disease due to vitamin A deficiency. In 1986, a joint WHO/FAO Mission to Bangladesh stated that 70,000,000 people in Bangladesh (70% of the total population) are affected by chronic dietary deficiency of vitamin A (3). The Mission's report also noted that the recent studies by Sommer et al in Indonesia suggest that even mild to moderate deficiencies of vitamin A can lead to increased mortality rates in children (4). Other reports (5,6) suggest that vitamin A deficiency reduces growth and increases susceptibility and severity of diarrheal and respiratory diseases among children.

Although vitamin A deficiency is widespread throughout Bangladesh, it appears to be more severe in a belt extending across the country from the Northwest to the Southeast and to be more prevalent during the wet season from May until December. The deficiency is most severe among low income groups whose diets are substandard. Likewise, because the poor are generally more malnourished and more at risk of having diarrheal diseases, the problem of vitamin A deficiency particularly affects that group.

Accordingly, while the population of Bangladesh as a whole requires more vitamin A, it might reasonably be concluded that highest priority for vitamin A interventions should be given to the poorest families,to growing children, particularly young children who are most commonly affected by malnutrition and diarrheal diseases, and to the pregnant and lactating women who are the source of nutrients for unborn and breast fed children.

Since 1973, the GOB has distributed vitamin A capsules semiannually to 6 mo.-6 years old children through the Bangladesh Programme for the Prevention of Blindness (BPPB). UNICEF has supplied the capsules for the program since its inception. HKI has participated in the BPPB since 1978. The BPPB is believed to reach 8,000,000 children or 45% of its target group. It is estimated that the program prevents 8000 children a year from going blind and protects 240,000 from night blindness. However workers associated with BPPB are concerned that children from very low-income families are not covered effectively by the program.

Although the BPPB program has made a significant contribution to overcoming vitamin A deficiency, it is generally accepted that greater efforts should be made to expand coverage and to reach more persons among the at-risk groups. Also, because capsule distribution is typically considered a short-term emergency-type intervention, HKI believes Bangladesh should, if feasible, move toward more comprehensive, longer-term interventions such as food fortification with vitamin A and changes in dietary practices. This report is intended to review options for using fortification as a means of alleviating vitamin A deficiency in Bangladesh in order to assist HKI and BPPB consider possibilities for strengthening their activities through fortification interventions.

D. FOOD FORTIFICATION

Food fortification is a well known, widely practiced means of delivering micronutrients to large population groups. In principle, fortification involves the addition of micronutrients to a food so that the diets of persons consuming the food will be supplemented with the nutrients.

In some instances, such as in the iodization of salt, fortified foods can deliver nutrients to most if not all of the population in the area of distribution. In other cases, such as with the addition of vitamins and minerals to commercial weaning foods, coverage is limited to a specific population subgroup. Accordingly, the selection of a food to serve as a carrier for a fortificant should be based in part on the intended target population.

In the case of vitamin A in Bangladesh, a carrier which reaches the total population would be preferred because vitamin A deficiency is a widespread problem affecting 70% of the population. If such a carrier is not available, one should be sought that is consumed by the highest priority groups, viz growing children, pregnant and lactating women, and those who are the highest risk of having malnutrition and diarrheal disease, such as the poorest of the poor.

As a general rule of fortification, the fortificant should be added to the carrier at a level that provides beneficial amounts of the nutrient to members of the target group but not at levels that will create toxic effects or be wasteful. The state-of-the-art of vitamin A nutrition does not provide precise guidelines to establish fortification levels. However in practice, nutritionists often recommend that widely consumed foods should be fortified at levels to provide about one-half the recommended dietary allowance while foods for young children should generally be fortified to provide the full recommended dietary allowance. Because excess vitamin A can have toxic effects, the fortification level should be established so that no regular consumers of the product receives more than about five times the dietary allowance.

Vitamin A is one of the more expensive micronutrients. The bulk cost of vitamin A required to supply the total annual dietary allowance of synthetic vitamin A is roughly $0.10 for adults and $0.05 for children. Also the special processes required to fortify foods sometimes require procedures which can increase the cost of fortification as much as 2-3 times the cost of the vitamin A alone. Therefore special measures should be taken to avoid excessive use of the nutrient for economic as well as safety reasons.

Fortification requires a site, usually a central processing facility, where the fortificant can be added to the food under controlled conditions. Likewise, a practical technology of fortification is requires whereby fortification can be accomplished without significantly changing the character of the food and without damaging the fortificant. In some instances, fortification of foods with vitamin A can be accomplished simply by mixing commercially available vitamin A compounds with the food, for example, by mixing vitamin A powder with wheat flour or vitamin A liquids with vegetable oil. In some cases, however, special processes must be used to fortify foods to protect the vitamin A and to avoid changes in the properties of the food. Vitamin A is particularly susceptible to oxidation and can lose potency rapidly when exposed to light, oxygen, moisture, and heat and therefore sometimes requires special handling during fortification processing. Also, vitamin A compounds are yellow and can discolor white or light colored foods if used in large amounts. Under some circumstances, vitamin A can separate physically from the carrier leading to non-uniformity of fortification. Consideration must also be given to the ways in which the fortified food will be used in order to know that acceptability will not be effected by fortification and that storage and preparation of the food will not cause excessive losses of vitamin A. Consequently, each food fortification possibility must be considered to determine if a practical fortification technology is available and if the manufacturing and distribution system of the food can be adapted to accommodate fortification.

Finally, as a practical matter, the feasibility of fortification is dependent on finding a way to pay for the fortification. Total costs of fortification include not only the cost of the fortificant itself, which can be in the range of $0.05-0.10 per person per year, but also the costs of processing and monitoring the fortification as noted above. The costs of fortification must be paid either by the users through an increase in the price of the product or by some concerned agency such as the government of the country or a donor organization. Identifying a funding mechanism to pay the costs of fortification is a crucial part of developing a fortification program.

Current Fortification Activities in Bangladesh

At the present time only two widely distributed foods are fortified in Bangladesh--vegetable ghee and salt.

Approximately 20-25,000 tons per year of vegetable ghee (partially hydrogenated vegetable oil used as a substitute for butter oil) are fortified with imported vitamin A (30,000 IU/kg) and vitamin D (2500 IU/kg) (7). With vegetable oil consumption at 188,000 tons (1984/5), per capita consumption is roughly 5 grams per day (8). Assuming that an individual consumer used vegetable ghee as his exclusive source of oil, on the average he would receive only about 150 IU per day of supplementary vitamin A or about 5% of the requirements. In addition, only about 13 percent of the population would consume fortified vegetable ghee. In all likelihood, however, vegetable ghee consumption is skewed toward greater use among upper income groups so that those groups receive a higher proportion of their vitamin A requirements from vegetable ghee. Similarly, the low-income groups, those targeted by HKI, probably consume very little vegetable ghee and therefore receive very little vitamin A from this source.

With respect to salt, Bangladesh consumes approximately 600,000 tons of salt per year of which 500,000 is consumed as food and 100,000 is used for processing leather and for other non-food applications (9). UNICEF, working with the Ministry of Industries, has developed a $7.3 million project to iodate the salt produced in Bangladesh and thereby control iodine deficiency disorders (10). Although the project has not yet been formally approved by the GOB, three salt refineries have been equipped to fortify salt with potassium iodate at levels that will deliver 300 micrograms of iodine per person per day. It is planned that essentially all of the 210 salt refineries operating in Bangladesh will be equipped to iodate salt during the five year life of the project. Since salt is more or less uniformly consumed, nearly everyone in the population is expected to obtain beneficial amounts of iodine regularly, and, if the project is successful, iodine deficiency disorders should be eliminated as a public health problem.

While some imported commodities such as milk powder and infant foods are fortified with various vitamin and minerals, these are not believed to reach large segments of the population or to be consumed significantly by the low income target groups.

Options for Fortifying Food with Vitamin A to Reach Low-Income Groups

Processed foods which reach large numbers of persons in Bangladesh and might be considered as carriers for vitamin A include those listed below in Table 1.

Table 1. Processed Food Consumed by Large Numbers of Persons in Bangladesh

Food Item	Estimated a/ Annual Food Consumption (1000 tons/year)	Estimated Daily per Capita Consumption (g/day)
Rice (milled)	15,874 b/	435
Wheat	3,304 b/	121
Sugar - Unrefined (Gur)	700 c/ d/	19.2
- Refined	255 c/	7.0
Salt	500 e/	13.7
Vegetable Oil	188 c/ d/	5.2
Biscuits	30-90 f/	0.8 - 2.5
Tea	12 c/	0.3

a/ 1986 unless otherwise noted
b/ USDA/FAS BG6001 (11)
c/ USDA/FAS, BG6004 (8)
d/ 1984-5
e/ UNICEF (10)
f/ Shilpee Food Products Ltd., Dhaka. (12)

1. Rice

Parboiled rice is the major food staple of Bangladesh. Nearly everyone consumes rice regularly if they can afford to buy it. Except for wheat, rice is the least expensive, commonly available food in the country. Per capita consumption of rice is 435 grams per day and it supplies over 1500 calories and nearly 35 grams of protein per person per day. If it could be successfully fortified, rice could serve as a carrier to reach most of the people of Bangladesh.

A process is currently in use commercially in the U.S. to fortify rice by mixing the rice with a small amount of fortification "premix". The fortification "premix" is made by gluing powdered micronutrients to the surface of rice grains with an edible adhesive (such as food grade shellac). Nutrients applied to rice in this way cannot be lost during shipping and handling and the rice can be rinsed with water without significant loss. However, the nutrients are released during cooking and, if excess water is used for cooking and the water is discarded, the nutrients can be lost. In the U.S., rice is routinely fortified with niacin, thiamine, and iron, using this process. While this process has not been used to fortify rice with vitamin A, the technical feasibility of its use has been demonstrated by the commercial producer of rice "premix", the Wright Enrichment Co. of Crowley, Louisiana. Therefore if it were feasible to add rice "premix" to rice in Bangladesh and if rice were not cooked in excess water, vitamin A fortification of rice might be a practical option

Typically rice paddy is parboiled and milled as a cottage industry-type operation in perhaps thousands of small enterprises around Bangladesh. The rice generally does not pass theough a centrallized processing and distribution system where fortification "premix" could be added in a controlled way.

Also, anecdotal reports indicate that rice is generally cooked in excess water so that fortificants would be expected to be lost during cooking.

While it is conceivable that an improved technology might be developed so that nutrients would be retained in the rice during cooking, and while it's possible that some reliable method can be found for adding "premix" to the rice, perhaps even at the home level, these possibilities seem unlikely at this time. Therefore fortification of rice with vitamin A does not appear to be a viable option.

2. Wheat

The production and consumption of wheat in Bangladesh have grown rapidly in recent years. Of the 3.3. million tons of wheat currently consumed in Bangladesh, 1.5 million tons are produced locally and the remainder imported. Imports are largely from the U.S., Canada, the EEC, and WFP, most of which are supplied on a concessional basis.

Wheat is less costly than rice 2/ and therefore has entered the diets of low-income families as an important food staple. The per capita consumption of 121 grams of wheat per person per day probably does not reflect the high consumption rate among the poorest of the poor. Consumption by low-income families is not known but could be as high as 400-500 grams per day. As a result, wheat might be considered as a carrier for vitamin A to reach low income groups.

2/ The retail price of superior quality wheat flour (atta) is roughly 20% cheaper than the least expensive, coarse grade rice.

Wheat flour which is produced in modern roller flour mills can be easily fortified with vitamin A by adding vitamin A in powder form to the flour during milling. The technology is extremely simple, the equipment inexpensive, and the procedures, which have been practiced in the U.S. and elsewhere for many years, could be rapidly implemented in Bangladesh.

Unfortunately the wheat flour consumed by low income families is not generally milled in modern roller flour mills but instead is milled in many local chukki mills (stone mills) where it is ground into whole meal atta by small enterpreneurs. As in the case of the rice mills, it is probably not realistic to consider fortification of wheat flour at chukki mills because of lack of control. However if the whole wheat which is ground in the chukki mills were prefortified with vitamin A, then the atta produced in these mills would be expected to retain the fortificant and be properly fortified.

Whole wheat has never been fortified in commercial operations. However the technology for fortification of rice, which was described in the previous section, should also be applicable to wheat. The Wright Enrichment Co., which produces rice "premix", has experimentally produced a wheat "premix" for fortifying wheat with vitamin A and considers wheat fortification to be technically feasible. Commercial-scale fortification would only require mixing a small proportion of wheat "premix" with the remainder of the wheat in a simple mixing device such as a cut-flight screw conveyor. The "premix" could contain about 1.0 million IU of vitamin A per pound and could be added in whatever proportion is required to give the desired content of vitamin A in the wheat. (For example, if the wheat needs to contain 6000 IU/kg, then 3 kg of premix should be added to each ton of wheat).

At practical levels of fortification, there should be no perceptable difference between fortified and unfortified wheat. However tests should be undertaken to verify that consumers find the product to be acceptable, and that the vitamin A in fortified wheat is sufficiently stable to withstand distribution and consumption practices in Bangladesh.

While locally grown wheat probably cannot be fortified (because it is not handled in centralized facilities where "premix" can be added under controlled conditions), imported wheat might be fortified either in the country of export or in Bangladesh at the port of entry and the fortified wheat might be distributed in ways so that it will reach a large number of persons in the target roup. Possibilities for implementing a wheat fortification program in Bangladesh will be discussed later in this report.

3. Sugar

In Bangladesh, sugar is consumed largely in the form of gur which is homemade brown sugar. Roughly 700,000 tons of gur were produced in 1984/5 which corresponds to a per capita consumption of 19 grams per day. A limited amount of white refined sugar is also produced (80,000 tons in 1985/6) and the government imports additional supplies (175,000 tons in 1985/6) so that per capita consumption of refined sugar is roughly 7 grams per day. The retail price of refined sugar is about 50% greater than that of gur so that consumption of gur would be expected to be skewed toward low-income families and refined sugar toward upper income families. Therefore refined sugar is not a good candidate for fortification to reach the low-income target group.

While a technology has been developed for fortification of refined sugar as produced in large centralized sugar refineries (6), no technology is

available for fortification of gur. Also, since gur is typically produced in small cottage-industry type operatons or in the home, it seems unlikely that its fortification could be controlled adequately even if a technology were available. Consequently, sugar fortification does not appear to be a feasible option.

4. Salt

Bangladesh produces and consumes roughly 600,000 tons per year of which 500,000 tons is used for human food and 100,000 is for industrial purposes. Per capita consumption of 14 grams per day is believed to be relativey uniform throughout the country and to be independent of socio-economic status.

Crude salt is produced from sea water by solar evaporation and is refined in 212 salt crushing/refining units where the crude salt is washed, recrystallized, and bagged for distribution throughout Bangladesh. In the refining process, excess brine is drained from the salt, but it is not dried. Consequently the salt normally contains a substantial amount of water, reportedly about 5%, and is sometimes wet to the touch.

As noted earlier, UNICEF is currently providing support to Bangladesh for a project to control iodine deficiency disorders in Bangladesh by iodating all the edible salt produced in the country. The project calls for installation of iodation equipment in all the refineries in Bangladesh by 1990. although the project has not been formally approved, successful pilot tests have been completed and three of the refineries have been equipped and operated to produce iodated salt 3/.

3/ Salt is iodated by spraying a solution of potassium iodate onto the refined salt in an amount needed to add 40-60 ppm of iodine. However, up to 2/3 of the iodine is dissipated before it reaches the consumers, probably in part because of the high moisture content of the salt.

Although salt iodation is a well-known technology, salt has not served as a carrier for other micronutrients in public health programs. Recent studies at Iowa State University (ISU) have indicated that salt fortification with vitamin A under some circumstances might be feasible. Various commercial forms of vitamin A were found to be stable when added to dry salt, but it was found that vitamin A losses potency rapidly when the salt is wet (13). While work at ISU is continuing in order to examine possibilities for stabilizing vitamin A in the presence of moisture, a technology is not yet available to fortify wet salt of the type produced in Bangladesh. 4/ Unless or until a satisfactory technology is found that permits fortification of wet salt, vitamin A fortification of salt in Bangladesh is not considered to be feasible

5. Vegetable Oil

Consumption of vegetable oil in Bangladesh during 1984/5 was 188,000 tons or roughly 5 grams per person per day. Domestic production accounts for about one-third of the supply. Mustard/rapeseed oil is about 80% of the local oilseed production. Imports include crude soybean oil, rapeseed, and palm oil.

A total of 19 vegetable oil refineries are operated in Bangladesh in which 40-45,000 tons per year of oil are refined and packaged and 20-25,000 tons are refined and partially hydrogenated to make vegetable ghee (7). Vegetable ghee is fortified with vitamin A (30,000IU/kg.) and vitamin D (2400 IU/kg).

4/ Samples of Bangladesh salt have been provided to ISU for evaluation as a carrier for vitamin A. Results of the evaluation will be reported to HKI.

Vegetable oil, particularly refined oil and vegetable ghee, is an expensive food commodity in Bangladesh and this accounts for the low per capita consumption. Poor families undoubtedly consume less than the average and probably use very little if any of the vitamin A fortified vegetable ghee. 5/ Consequently fortification of vegetable ghee with vitamin A does little to benefit the poor, and likewise, fortification of other centrally processed vegetable oils would be unlikely to be helpful. As a second argument against vegetable oil fortification, if enough vitamin A were added to the oil consumed by low-income families to have a beneficial effect, upper income families, who consume oil at a much higher rate, might be caused to ingest toxic amounts of vitamin A. Therefore, under present circumstances, fortification of vegetable oil appears to be an unsatisfactory approach to alleviating vitamin A deficiency among low-income families.

6. Biscuits

Biscuits (cookies) of various kinds are found in food shops and markets throughout Bangladesh. Biscuits can be fortified with vitamin A either by fortifying the ingredients, such as wheat flour, or adding the vitamin during biscuit manufacture. Also, biscuits are known to be used almost universally as a snack for children. Therefore, at least on the surface, biscuits might seem to be a candidate for vitamin A fortification.

Contacts with the biscuit trade in Bangladesh indicate that biscuit production is relatively small amounting to only about 30,000-90,000 tons per year (12). This corresponds to a per capita consumption of 0.8-2.5 grams per person per day. The low consumption rate implies that consumption is probably irregular and variable. Because biscuits cost roughly 2-3 times as much as rice, and are a semi-luxury item, it also seems likely that biscuits

5/ Fortified vegetable ghee delivers on the average only20 IU per person per day.

are consumed in much smaller amounts by lower income groups compared to upper income groups. Thus the arguments used to suggest that oil fortification is not feasible also pertain to biscuits.

7. Tea

During the early 1970's the possibilities of using tea as a carrier for vitamin A were explored by the Government of India with assistance from USAID/India and Hoffman-LaRoche, Nutley, New Jersey (14). That study together with subsequent AID-sponsored work in Pakistan by International Venture Research, Chaska, Minnesota (15) showed that tea can be fortified with vitamin A and that the vitamin A retains its potency even after the tea has been boiled for up to one hour during tea preparation. It was found that consumers drink from one to several cups of tea per day, and that typically each cup is made with about 3 grams of tea. The studies also concluded that tea is widely consumed among the poor on the subcontinent, even among young children, so that it should provide good coverage of low income families including children.

Tea is produced in Bangladesh and is a major export. The production target for 1985/6 is 44,000 tons of which 32,000 is expected to be exported (6). Thus domestic consumption is expected to be 12,000 tons or 0.3 grams per person per day.

The low consumption rate of tea inmplies that it is not widely consumed in Bangladesh or that it is consumed only on special occasions rather than on a regular basis. In either case, tea would not be expected to be an effective carrier to deliver vitamin A to the target group and should not be considered as an option.

Wheat Fortification in Bangladesh

Wheat appears to be the only food among those examined which is technically feasible to fortify and could also reach a large segment of the target population. While some of the other foods have potentially better coverage (salt and rice), new technologies are needed in order to utilize their potential in the environment of Bangladesh. Likewise, although technologies exist for fortification of some of the other commodities (sugar, oil, biscuits and tea), coverage of the target group seems poor. Therefore, although wheat is not an ideal carrier because it would not reach the entire population at this time, it is the best of the candidates and merits further exploration. In the following sections, wheat fortification in Bangladesh will be reviewed in terms of processing, distribution, potential coverage, costs, institutionalization, and project development.

1. Processing

Of the 3.3 million tons of wheat consumed in Bangladesh annually, about 1.8 million is imported and can be fortified without radical changes in the distribution system. The imported wheat can be fortified in the country of origin or at the port of entry in Bangladesh as explained below. Most domestically produced wheat enters commerce without passing through a centralized control point where it can be fortified.

As explained previously, wheat can be fortified by mixing a small proportion of vitamin A "premix" with the remainder of the wheat in a simple blender. Mixing can take place in a batch blender, such as a ribbon blender, where weighed amounts of the wheat and the "premix" can be added and mixed for a few minutes to provide a uniform product. Alternatively, mixing can take

place continuously in a conveying system by metering the "premix" into the wheat conveyor in the proper proportion. A cut-flight screw conveyor a few feet long can provide adequate mixing.

The capital costs for a batch mixing system which could fortify about 25-50,000 tons/year need be no more than $10,000-25,000. Costs for feeders and mixers for a continuous wheat handling system such as those in the governments' silo in Chittagong which has conveyors handling 100-200 tons/hour, should also cost only $10,000-25,000. In either case, capital costs are very small. Labor and other operating costs associated with blending are not known but should not be great if fortification is done in Bangladesh.

The wheat "premix" must be manufactured under carefully controlled conditions. While Bangladesh can establish a manufacturing facility to produce "premix" it would be desireable in the intitial stages of a project to purchase "premix" from an existing supplier. Costs of "premix" containing 1.0 million IU/lb. should be approximately $0.30 per pound or less CIF. 6/

Because wheat has only been fortified with vitamin A on an experimental basis thus far, several technical assumptions must be confirmed before proceeding with a project. First, both "premix" and fortified wheat should be tested for physical and chemical stability under conditions of shipment, handling, and use representative of exposure in Bangladesh. This might be done by preparing test materials in the U.S., shipping them to Bangladesh for storage, milling, preparation in food, etc., and by checking for loss of vitamin A potency at key points along the way. Tests for acceptability of vitamin A fortified wheat could be conducted concurrently. Second, the practicality of fortifying wheat by batch and continuous mixing and the

6/ Rough estimate by Wright Enrichment Inc.

estimated costs for doing so should be confirmed by food engineers. Contacts with wheat suppliers and Bangladesh wheat handling organizations to assess feasibility and receptivity of fortification operations should be made and the preferred site for fortification (at the overseas supplier or in Bangladesh) and the equipment requirements should be established. And third, appropriate ministries in the Government of Bangladesh should be contacted to confirm that fortification of wheat poses no legal, regulatory, political, or other problems and can be carried out with government support.

2. Distribution

Wheat imported into Bangladesh is distributed through a network of government godowns which cover the entire country. The network handles not only wheat but also rice, vegetable oil, and a variety of other commodities. Wheat enters the network from Chittagong on the eastern side of Bangladesh and from Chalna in the west. Chittagong supplies about 60% of the wheat requirements, mostly through the Chittagong silo which handles 700,000 tons per year. The government-owned wheat from Chittagong flows to godowns servicing the eastern section of the country. Chalna services government godowns in the western section of the country.

All imported wheat is considered a part of a common pool from which the GOB draws to supply its various programs. The major programs which use GOB-supplied wheat include: ration shops, which supply food to government workers, modern roller-type flour mills which convert wheat to whole meal atta and to white flour for commercial markets, and donation feeding programs. Of these outlets, only the donation feeding programs appear to distribute the wheat selectively to low income families. These include the Vulnerable Group Feeding Program (VGF) and the Food for Work Program (FFW).

The VGF program is a nation-wide program intended to help alleviate malnutrition among distressed women and children by supplying dry, take home

rations and on site feeding, both of which are based largely on wheat. Each family received 31.25 kg. of wheat per month and a family consists nominally of a mother and three children. During 1986/7, the program is scheduled to distribute 168,000 tons of wheat. If it accomplishes it objective, it will reach 1,800,000 of the most impoverished, needy persons in Bangladesh and deliver 250 grams of wheat per person per day throughout the year. Fortification of the wheat used in the VGF program with vitamin A could therefore be a highly effective means of reaching a critical part of the target group.

The FFW program is also a nation-wide program which uses wheat as payment for labor to construct and maintain river embankments, canals and roads, and to perform other work in support of national development. The program is operational largely during the dry season (December-April) and therefore does not provide a uniform supply throughout the year. During 1986/7, a total of 480,000 tons of wheat are expected to be used by the FFW program. While the number of recipients and the amount of wheat made available to each recipient is not reported, a recent analysis by USAID/Dhaka (16) indicates a worker receives about 900 kg of wheat per manyear worked, and that typically a worker works 1½ months per year and has a family of 5. If it is assumed the typical worker is active during the five month major work season (Dec.-April), then he would receive a total of 113 kg of wheat and use it to provide food for his family of five during that 150 day period. Thus it can be estimated a total of 21 million beneficiaries receive roughly 150 grams per person per day of wheat during the work season.

Wheat used in both the VGF and FFW programs is distributed as bagged wheat through the government godown network. Therefore the government could, if it choose, arrange to distribute vitamin A fortified wheat through the existing network. This could be accomplished by bagging fortified wheat in

specially marked bags at the ports of entry and distributing that wheat as a special commodity. Since the godown network already handles several grain commodities, and since fortified wheat for the FFW and VGF programs amounts to 650,000 tons per year, over a third of all imported wheat, this should not pose insurmountable problems. Dicussions with some of the GOB managers of wheat operations in Chittagong indicated that use of special bags would cost no more and that the godown system could probably accommodate the additional commodity with a minimum of difficulty to distribute it throughout all of Bangladesh. However before proceeding with development of a project proposal for wheat fortification, the government wheat distribution system should be reviewed carefully to identify potential pitfalls and develop a workable plan for distributing fortified wheat.

3. <u>Potential Coverage</u>

As outlined in the previous section, wheat distributed through the Vulnerable Group Feeding Program (VGF) can reach up to 1.8 million of the most destitute persons in Bangladesh and the Food for Work Program (FFW) might reach another 21 million. Beneficiaries of these programs normally receive 150-250 grams of wheat per person per day while the programs are active. Fortification of this wheat with 6,000-10,000 IU of vitamin A per kilogram of wheat could therefore supply one half the RDA to about 20-25 million recipients.

These estimates of coverage are extremely rough and should be adjusted to reflect imperfections in the programs and possible inaccuracies in the assumptions. For example, the programs probably do not deliver the projected amounts of wheat and therefore the coverage is likely to be less than estimated. Also some of the wheat delivered to the program recipients is likely to be sold or otherwise diverted from the intended beneficiaries,

thereby effecting the number of recipients or amount consumed. Also, because the FFW program only delivers food during the dry season, it is probably less effective than desired 7/.

These issues together with questions of potential nutrient losses during wheat distribution and food preparation should be examined carefully in order to assess coverage and determine specifically how much vitamin A should be used to fortify wheat.

4. Costs

As noted above, capital equipment costs for fortification are small, possibly as low as $10-25,000 to equip the Chittagong silo to add "premix". Operating costs include the costs for the vitamin A "premix" and associated costs for labor, supervision, utilities, quality control, etc. The cost of "premix" is overwhelmingly the largest of these costs and, as a first approximation, the total cost of fortification can be taken as the cost of premix. Using a cost of "premix" of $0.30 per million IU 6/, the total direct costs of fortification are:

	Costs (US$) Fortification Level of wheat (IU/kg)			
	3000	6000	10,000	15,000
1.0 Kg of wheat	$0.0009	0.0018	.0030	0.0045
1.0 ton of wheat	0.90	1.80	3.00	4.50
168,000 tons of wheat- (VGF Reqt/yr.)	151,000	302,000	504,000	756,000
480,000 tons of wheat- (FFW-Reqt/yr.)	432,000	864,000	1,440,000	2,160,000
648,000 tons of wheat- (VGF plus FFW Reqts/yr.)	583,000	1,166,000	1,944,000	2,916,000

7/ Because vitamin A is stored in the liver, it is possible that enough vitamin A can be delivered during the dry seacon to meet the total needs of the beneficiaries.

If the estimated fortification level shown in D-3 above is correct (6,000-10,000 IU/kg), then the total cost of fortifying all the wheat used in the VGF and FFW programs (648,000 tons per year) is about $1-2 million per year and the program might reach 20-25,000,000 persons.

In addition to the direct costs for fortification, certain additional costs should be anticipated in connection with (1) developing the project including undertaking preproject feasibility studies, and pilot tests including impact studies if required, (2) monitoring the project by continuously assessing the processing and distribution system for effectiveness and possibly monitoring the nutritional impact of the program, and (3) providing public information through mass media and other channels to assure the public that fortification is safe, effective, and in the public interest. The cost of these ancillary activities depend on the degree of effort judged to be needed in Bangladesh. The judgement should be left to an appropriately constituted project design team.

5. Institutionalization

An agency within the government of Bangladesh will be required to serve as the implementing organization. It is premature to suggest which agency might best serve in that capacity.

6. Project Development

As noted above, certain information is required, in order to decide if wheat fortification with vitamin A can be a feasible program in Bangladesh. This information relates to (1) the feasibility of adapting the existing wheat distribution system to fortification of imported wheat and delivery of the fortified wheat to VGF and FFW beneficiaries, and (2) determining the consumption patterns of wheat among VGF and FFW beneficiaries to assess the potential coverage (and leakage) of fortified wheat in order to judge poten-

tial impact of the program. If the distribution system cannot be easily adapted to deliver fortified wheat, or if a large proportion of fortified wheat does not reach the target group in amounts that could have beneficial impact, then a project is not merited. But if the converse is true, it would be appropriate to move forward with project development. Therefore these issues should be resolved through feasibility studies prior to project development.

Assuming a favorable outcome of the feasibility studies, a project should be designed for consideration by HKI, the GOB, and appropriate funding institutions. Because fortification of wheat would be expected to reduce child mortality as well as reduce blindness, USAID/Dhaka or AID/W might wish to consider support through the Vitamin A and Child Survival Action Programs. Other international donor organizations might also be interested.

Using the feasibility studies as basis for project development, a project design team should be able to draft a project proposal over a period of 3-4 weeks. The design team membership should include a fortification specialist as well as a nutritionist specializing in assessing and monitoring impact of vitamin A interventions. The team should also have a member who is knowledgeable about Bangladesh institutions and decision-makers in order to be sure the team takes into account the concerns of all local institutions. If the team members are not all Bangladeshis, appropriate local counterparts should be identified to collaborate with each team member.

E. CONCLUSIONS AND RECOMMENDATIONS

An analysis of possibilities for fortifying foods with vitamin A to increase consumption among vulnerable groups in Bangladesh indicates that fortification of the imported wheat used in GOB Vulnerable Group Feeding Programs and Food for Work Programs appears to have the greatest potential. Wheat fortified with a vitamin A "premix", similar to that used commercially to fortify rice can probably be delivered to VGF and FFW recipients through the existing GOB food distribution network which is now used to distribute ordinary wheat to those groups. Up to 20-25,000,000 persons among the poorest of the poor in Bangladesh could be reached through a wheat fortification program. Fortification of the roughly 650,000 tons per year of wheat used in the programs is estimated to cost in the range US$ 1-2 million per year.

A number of issues require further analysis before giving serious consideration to the development of a specific wheat fortification project. These include:

- Can the existing wheat import and distribution system be adapted to fortify wheat and deliver the wheat to VGF and FFW recipients? What adjustments in the system are required and how much will the adjustment cost?

- How much of the wheat delivered to VGF and FFW programs is consumed by the groups most affected by vitamin A deficiency and how much is sold or otherwise diverted to non-vulnerable groups? What are the wheat consumption patterns of the recipients -- how much and how often is the wheat consumed, and how is it prepared? (This information is needed to assess losses of vitamin A in the delivery system and establish fortification levels.)

It is recommended that these issues be addressed through feasibility studies, and, if the results are favorable, a wheat fortification proposal be developed for consideration by the GOB and by potential funding agencies.

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